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WO 93/19479 A1 WO 93/19405 A1 US 5523776 A  
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(54) Combined liquid crystal display and photovoltaic convertor

(57) A transparent photovoltaic generator structure, formed between plates 2 and 3, is combined with a liquid crystal device, formed between plates 1 and 2, in a single stacked structure. Power derived from the convertor is used to power, or to assist in powering, the display or an apparatus in which the device is used. The advantage is that, because both devices occupy the same area, apparatus incorporating them can be made more compact.

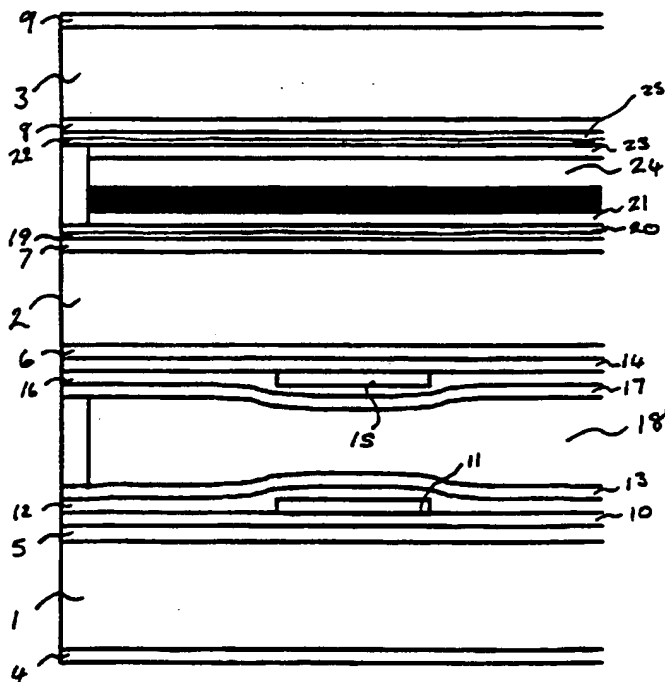


Fig. 1.

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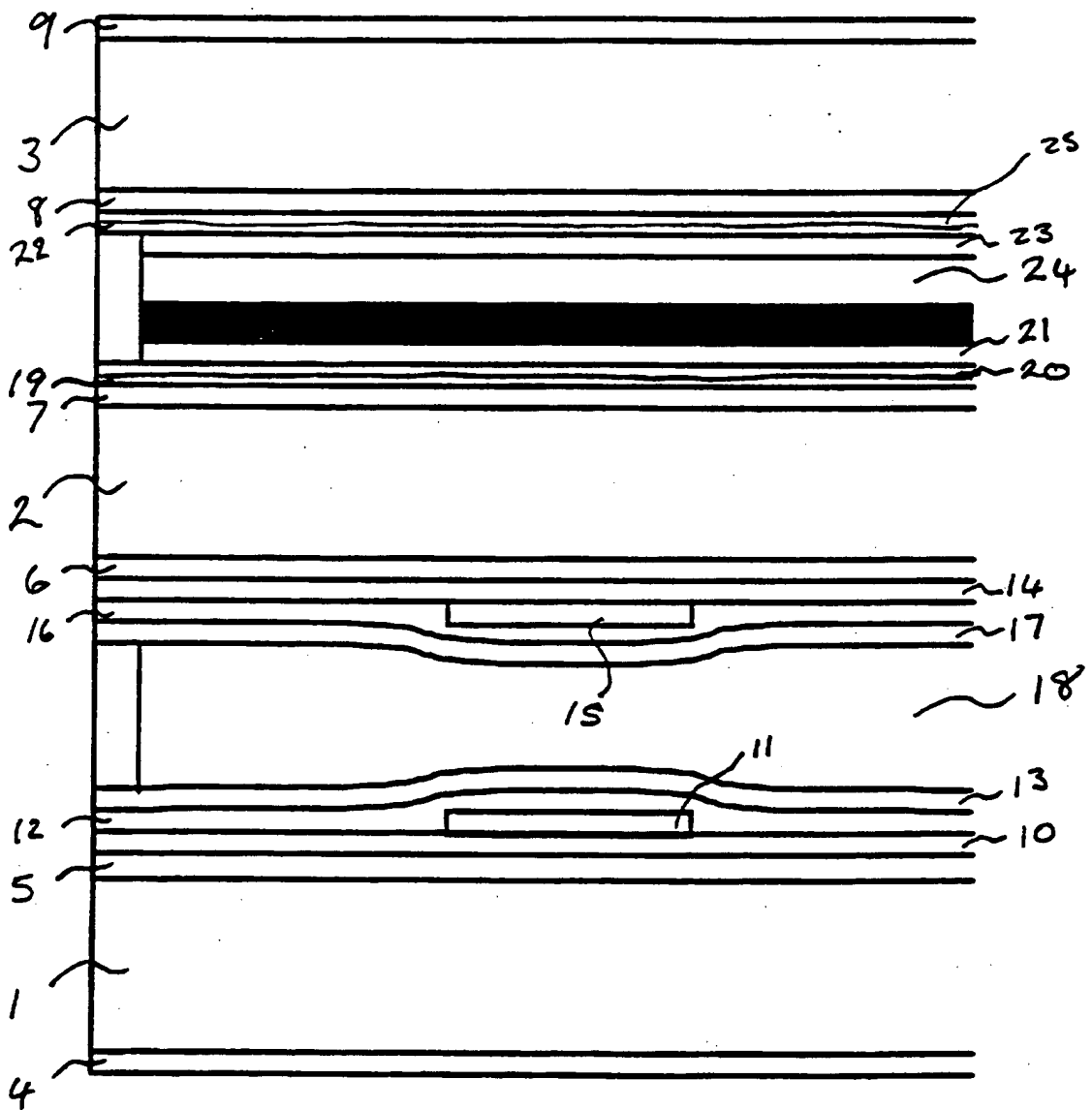


Fig. 1.

2/2

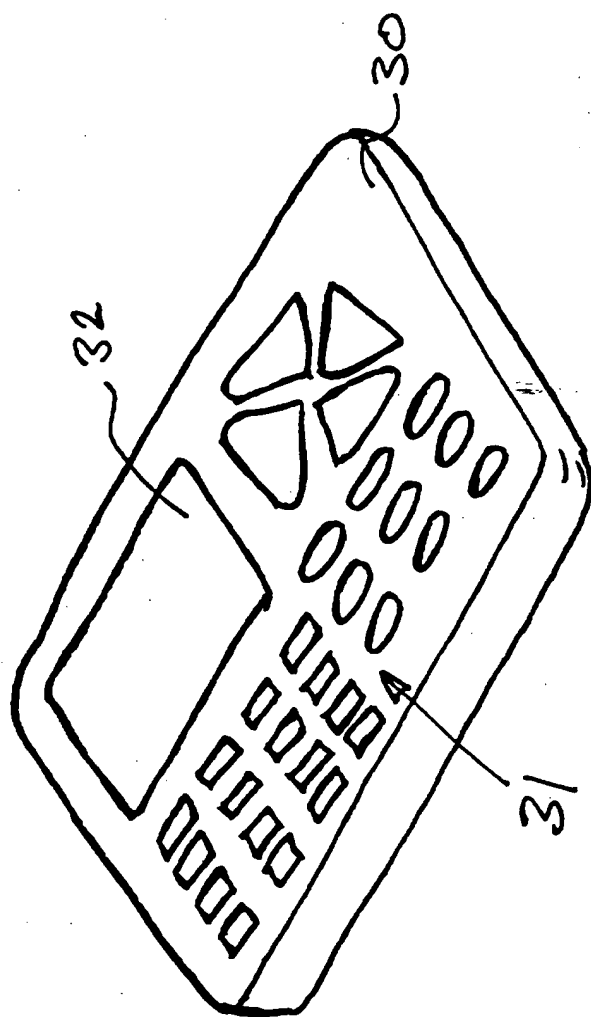


Fig. 2.

## Combined Display and Power Source

### Description

The present invention relates to a combined display and power source structure and  
5 apparatus employing such a structure.

In order to avoid the need for batteries or extend the life of batteries, portable  
electronic apparatus often includes solar cells. However, the area required for solar  
cells is essentially wasted space as far as a user is concerned.

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It is an aim of the present invention to provide for more compact solar powered  
apparatus.

To this end, the present invention provides a combined display and power source  
15 structure comprising a display panel and a transparent photoelectric generator in  
stacked relation. The photoelectric generator may be above or below the display  
panel or there may be photoelectric generators above and below the display panel.  
Alternatively, a plurality of photoelectric generators could be stacked one upon  
another. Since the photoelectric generator is transparent, the display panel can be  
20 back lit for use in low light conditions.

Preferably, the generator comprises a photoelectrochemical cell.

Preferably, the display panel comprises a liquid crystal display. However, it could be  
25 a gas discharge panel or an array of LEDs.

In a preferred embodiment, the structure comprises three sheets wherein a first and a  
second of the sheets define the liquid crystal display and the second and third of the  
sheets define the photoelectrochemical cell.

30

The sheets are preferably of plastics material. However, glass may be used and different sheets may be formed from different materials.

5 A structure according to the present invention may be used in an electronic apparatus, for instance a personal organiser, a portable computer, a calculator or a digital watch.

The structure may be formed in situ. That is, a display and power source may be mounted individually in an apparatus such that the combined structure has been  
10 formed when the apparatus is fully assembled.

An embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a cross-sectional view of a structure according to the present invention;  
15 and

Figure 2 shows a personal organiser incorporating a structure according to the present invention.

Referring to Figure 1, a structure according to the present invention comprises a first  
20 transparent plastic sheet 1, a second transparent plastic sheet 2, overlying the first plastic sheet 1 and spaced therefrom, and a third transparent plastic sheet 3, overlying the second plastic sheet 2 and spaced therefrom. The transparent sheets 1, 2, 3 are formed from acrylic, epoxy or polyethyl sulfone resin.

25 The major faces of each of the sheets 1, 2, 3 are provided with hard layers 4, 5, 6, 7, 8, 9. The hard layers are formed by coating the sheets 1, 2, 3 with a solution containing an organosilane, acrylic, melamine or urethane resin and silicon dioxide particles. The coatings are then sintered.

30 A liquid crystal display device is formed between the first and second sheets 1, 2. The liquid crystal device comprises an undercoat layer 10 over one of the hard layers 5.

The undercoat layer 10 comprises silicon dioxide and is 600 Å thick. A transparent electrode 11 is formed on the undercoat layer 10 from a mixture of indium oxide and tin oxide and is 2000 Å thick. A protective topcoat 12 and an orientation film 13, formed in a conventional manner, overly the transparent electrode 11.

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The opposite face of the second sheet 2 is similarly provided with an undercoat layer 14, a transparent electrode 15, a topcoat layer 16 and an orientation film 17. The space between the orientation layers 13, 17 is filled with liquid crystal material 18.

10 A photoelectrochemical cell is formed between the second and third sheets 2, 3. An undercoat layer 19 of silicon dioxide is formed over the hard layer 7 on the face of the second sheet which is directed away from the liquid crystal material 18. A transparent electrode 20, comprising a mixture of indium oxide and tin oxide, is formed over the undercoat layer. A layer of an oxide semiconductor 21 is formed  
15 over the electrode 20. The oxide semiconductor may be titanium oxide.

The opposed surface of the third sheet 3, is provided with an electrode layer 22 of a mixture of indium oxide and tin oxide over a silicon dioxide undercoat layer 25 formed on the hard layer 8. An electrocatalytic layer 23 is formed over the electrode  
20 layer 22. The electrocatalytic layer 23 is a few atoms thick and comprises platinum, ruthenium, rhodium, palladium, iridium or osmium.

The space between the oxide semiconductor layer 21 and the electrocatalytic layer 22 is filled with an electrolyte 24. The electrolyte comprises the redox couple of cerium  
25 (III) sulphate and cerium (IV) in solution in N-methyloxazolidinone. The electrolyte 24 contains colloidal particles 25 of an oxide semiconductor such as titanium oxide.

Further details of materials, including solid electrolytes, suitable for the photoelectrochemical cell can be obtained from WO-A-93/19479.

From the foregoing, it will be appreciated that there is considerable similarity between the layers required for the liquid crystal display and those required for the photoelectrochemical cell. Consequently, a number of manufacturing processes serve both for production of the photoelectrochemical cell and the liquid crystal display.

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Referring to Figure 2, an electronic personal organiser 30 comprises a plurality of keys 31 for operation by a user and a combined display and power source 32. A back light, not shown, is provided. The back light can be turned on during low light conditions so that a user can read the display.

10

Although not essential, the photoelectrochemical cell is preferably sensitive to UV or IR light and relatively insensitive to visible light.

## Claims

1. A combined display and power source structure comprising a display panel and a transparent photoelectric generator in stacked relation.
- 5 2. A structure according to claim 1, wherein the generator comprises a photoelectrochemical cell.
3. A structure according to claim 2, wherein the display panel comprises a liquid  
10 crystal display.
4. A structure according to claim 3, comprising three sheets wherein a first and a second of the sheets define the liquid crystal display and the second and third of the sheets define the photoelectrochemical cell.
- 15 5. A structure according to claim 4, wherein the sheets are of plastics material.
6. An electronic apparatus including a structure according to any preceding claim.
- 20 7. A combined display and power source structure substantially as hereinbefore described with reference to Figure 1 of the accompanying drawings.





Application No: GB 9626102.9  
Claims searched: 1 to 7

Examiner: Grant Bedford  
Date of search: 29 January 1998

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): G5C (CHX)

Int Cl (Ed.6): G02F 1/133, H01G 9/20

Other: Online: WPI

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
Y	WO 93/19479 A1 (ASULAB) See whole document.	1 to 7
X	WO 93/19405 A1 (ASULAB) See whole document.	1 to 7
Y	US 5523776 A (IBM) See whole document.	1 to 7
Y	US 4095217 A (HIROTSUGU) See whole document.	1 to 7

X Document indicating lack of novelty or inventive step  
Y Document indicating lack of inventive step if combined with one or more other documents of same category.  
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